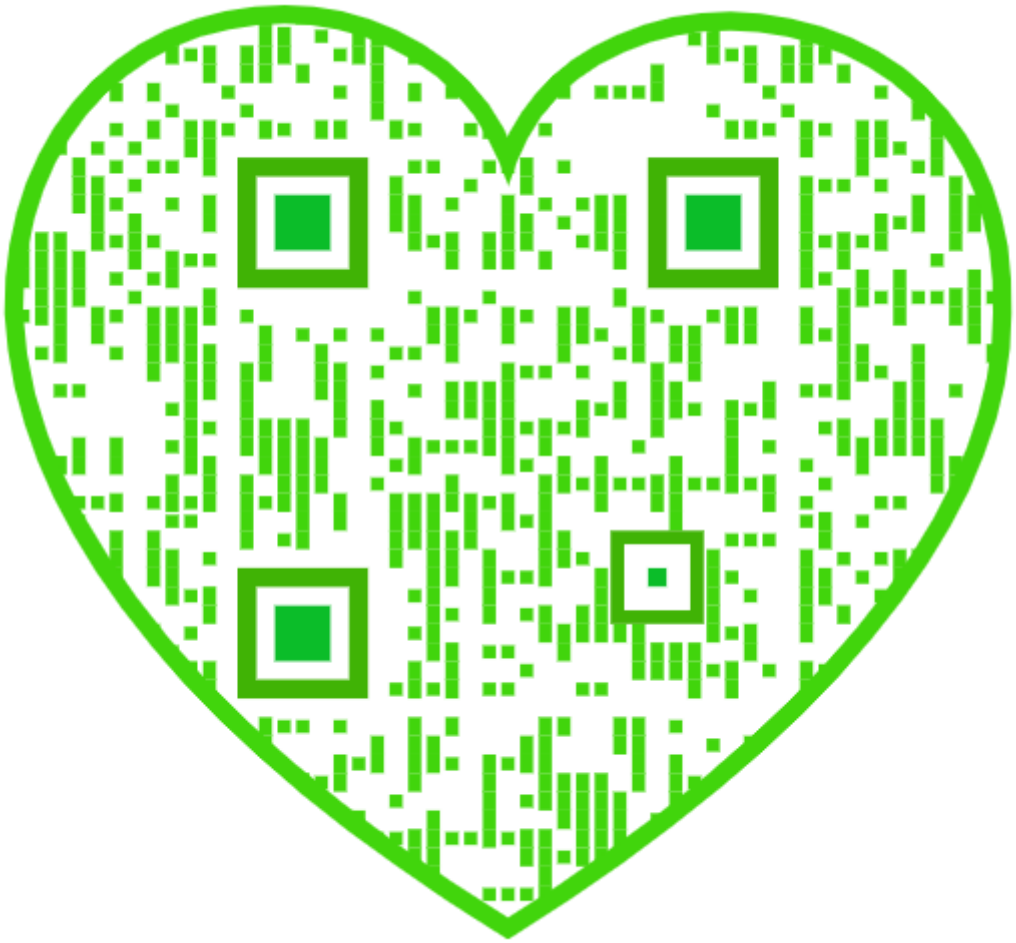

Porto Rico Agricultural Experiment Station,

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Coffee Planting in Porto Rico,

—BY—

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UNDER THE SUPERVISION OF
OFFICE OF EXPERIMENT STATIONS,
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MAYAGUEZ:
OFFICE OF "EL CENTINELA."
1904.

PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. True, Director of the Office of Experiment Stations, United States Department of Agriculture.]

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COFFEE INVESTIGATIONS IN PORTO RICO.

FRANK D. GARDNER.

The investigations of the Agricultural Experiment Station with reference to coffee have been in progress for about two years and are confined chiefly to two lines of work, viz., the improvement of an old plantation and the establishment of a new one. Since time enough has not elapsed to draw conclusions from these investigations we will not go into details but merely describe in the briefest manner the work that is in progress, in order to advise the coffee planters, who for the most part have not had an opportunity to learn what the Experiment Station is doing, just what is being attempted with reference to the improvement of their chief crop.

These experiments are situated about 15 miles directly north of the city of Ponce in the Bario of Hanon, and on the estate known as the "La Carmelita," which is operated by a company of the same name. They are accessible from Ponce by a road which passes up the valley of the Rio Cerillo and are also accessible from Adjuntas, Utuado and Jayuya by trails.

IMPROVING OLD PLANTATION.

The work of improving an old plantation consisted, first, of selecting ten acres of coffee and dividing it into ten plots of one acre each. No treatment was given until the crop of 1902 had been harvested. The product of each plot was kept separate, with the following result:

PRODUCT OF COFFEE FROM EACH OF TEN ACRES, 1902.

ACRE No.	1	2	3	4	5	6	7	8	9	10	Total
RIPE BERRIES:											
In liters.....	1,800	1,516	2,520	2,659	369	597	378	278	545	523	11,185
In pounds...	2,477	1,973	3,415	3,752	500	852	529	383	701	711	15,293
COFFEE READY FOR MARKET:											
In pounds....	545.5	459.5	763.5	805	113	181	114	84	163	158.5	3,387

The gathering of the berries was paid for at the rate of 7 cents per almud, there being 559.25 almudes, amounting to $39.15.

This quantity of berries produced 3,387 pounds of coffee ready for market, therefore:

1 almud of berries equals about 6.00 lbs ready for market.
1 pound of berries equals about 0.22 lbs ready for market.
1 liter of berries equals about 0.30 lbs ready for market.

The cost per 100 pounds of harvesting, preparing and marketing the coffee was as follows:

Picking	$1.16
Pulping, hulling and drying	.60
Transporting berries from field to factory	.10
Transportation to Ponce market	.25
Total per 100 pounds	$2.11

After harvesting, both shade and coffee trees were roughly pruned, the ground carefully weeded and acres 1, 3, 4, and 8 were divided into one-fourth acre plots for the purpose of beginning certain improvement experiments. These plots were numbered 1 to 16, the first four numbers being of the original acre No. 1; the second four of acre No. 3; and so on. On eight of this new series of plots, trees were removed by cutting so that the remaining ones would stand at as uniform distances from each other as possible under the circumstances. On three of the plots the distance was about 6x6 feet, on another three 7x7 feet, and on two of them 8x8 feet. In this process there was removed from the 8 plots or two acres 1106 coffee trees and there remained 1039. Four other plots were left as checks and the four plots which were originally acre No. 8 had all coffee trees removed and on three of them the shade trees were also removed. Three of these plots were plowed and harrowed the fourth one consisting of flat rock with only a thin layer of earth was left intact. One was planted to soja beans, one to cow peas and another to alfalfa. These crops all came up well but the alfalfa was destroyed by heavy rains, still a few hundred plants came up later and are doing well and this plot will be reseeded. The other two crops grew to maturity and were plowed under. After the further preparation, these plots were planted out with coffee stumps and are now doing exceedingly well.

Two of the plots on which the trees were distanced 6x6 feet had all the coffee trees cut to stump about 6 inches above ground and on one of them all the shade trees were removed. New shoots soon began to spring from these stumps and as soon as they had attained a length of a few inches all but two opposite ones were removed. The shoots have grown

very rapidly but more so where the shade was removed. On plot 1 cow peas were grown and hoed under, and another plot has been given a liberal application of bat guano. All trees of the first 12 plots were cleaned by rubbing with rough cloth and afterwards painted with lime milk. Their general appearance has greatly improved.

New Coffee Plantation.

For the purpose of establishing a new plantation, 25 acres of virgin forest was secured. A part of this has been cleared, roads constructed and houses built. A number of plots have been prepared and set to Porto Rican coffee, planting at distances of 4 x 4, 6 x 6, 8 x 8, 10 x 10, and 12 x 12 feet, and in sufficient quantity so that experiments can be carried out with methods of pruning, application of manures, the growing of leguminous crops and shading. Other plots have been planted with varieties of foreign coffees.

The seedlings used were grown from selected seed planted first in seed beds and afterward transferred to nursery beds, both shaded by straw roofs. This artificial shade was gradually reduced until all was removed and the plants were growing in full sunlight. All inferior plants were thrown away when the plants were transferred from seed to nursery beds and the process repeated when plants were set in the field. In this way none but the best of plants are used. A considerable number of these seedlings have been sent to representative planters in different parts of the island and planted, one-half with shade and the other half in full sunlight.

Experiments in reference to the extermination of the coffee leaf miner by picking and destroying all infested leaves have been tried on several occasions but the indications are that this method would prove such a stupendous task that it would be impracticable.

Fuller details relating to the progress of the work can be found in the annual reports of the Experiment Station, but unfortunately they are published only in English and in a very limited edition.

The following paper by Mr. J. W. van Leenhoff, "How to Plant Coffee in Porto Rico," is a brief description according to his experience, of what, he deems the best way to grow coffee in Porto Rico. His many years of experience as a coffee planter in Java and Porto Rico should give weight to his opinions and make them worthy of the consideration of all who are interested in the subject. Mr. van Leenhoff has charge of the above mentioned investigations with coffee, and he gives to all visitors a most cordial reception and is never too busy to show them results of his work.

HOW TO PLANT COFFEE IN PORTO RICO.

J. W. Van Leenhoff

Selection of Soil.

Those intending to grow coffee in Porto Rico should use great care in selecting suitable soil. A consultation of Bulletin No. 3 of the Porto Rico Experiment Station, "A Soil Survey from Arecibo to Ponce," should be of great assistance to prospective planters in this respect. From said bulletin it may be seen that the best two types of soil for coffee which fall within the surveyed area are Adjuntas Clay and Alonzo Clay. Both of these types are heavy in texture and carry a high per cent of clay. These clay soils are, as a rule, subject to less erosion than the sandy ones, retain moisture better and wear much longer. Very sandy or gravelly soils, especially if closely underlaid by coarse gravel or broken rock, should be avoided. If such soils are virgin the coffee trees will grow well for a few years but will soon fall into a decline, owing to the rapidity with which such soils deteriorate under the washing of heavy tropical rains. After the humus and surface fertility of such soils are depleted they withstand drought poorly, because of their porous nature and the steep topography of most of the country which so quickly and completely drains away the water. The clay soils are more retentive of moisture and retain their fertility longer. They seem to prove a more congenial home for the roots of the coffee trees.

As a rule, the coffee lands are naturally well drained, but occasional small and comparatively level areas occur, which need artificial drainage. In constructing drains care should be exercised to so place them as to cause the minimum amount of erosion.

Other things equal, virgin forest land will give best results, on account of its greater fertility. Limited areas of such land are still available and although, as a rule, far in the interior and removed from roads and trails, its fertility and freeness from noxious weeds, thus reducing the subsequent cost of weeding the plantation, will often more than counterbalance the extra cost of clearing the land and the disadvantages of poor location.

Elevations of 1,000 feet and above are regarded as most desirable but it is probable that the importance of this is overestimated. Other conditions being favorable, very good crops are frequently grown at lesser altitudes. As a rule, the higher elevations have a greater rainfall and a cooler atmosphere. For this reason, less shade is required for the coffee.

Preparation of Lands.

Clear the land as thoroughly as possible and burn all the felled trees, brush and weeds; very heavy trees, too expensive to cut up, may be excepted. Do not, however, fell any trees standing on ridges, and wherever none occur there they should be planted, in belts of from 20 to 30 feet in width. These trees will act as wind breaks and may prove of immense value as a protection against very strong winds especially. Quick growing and strong trees are, of course, desirable. The greatest and heaviest belts should be planted on the side from which the prevailing wind blows.

The land being cleared, roads should be made and the soil well drained by small canals. The first shower will show at once where drains are necessary.

After this, the places where the coffee trees are to stand, should be staked. This staking or lining is done by means of two long ropes. One rope is spanned at one side of the field and a laborer with a measuring stick goes along it, putting sticks at the desired distances. The second rope is spanned at right angles to the first one, at a point marked by one of the sticks, the laborer again putting sticks along this line according to the measure. The second rope is then spanned from the next stick on the first line and parallel with its first position; the sticks being again placed and this operation repeated until all the lines from all the sticks on the first rope are made. The first rope is then taken up and spanned further on, and the operation repeated until the field is completed.

The distance between two sticks (plant distance) is a question of much importance, but one which, up to the present, has been generally disregarded in Porto Rico. This distance should be great enough so that, after the coffee trees have grown up, their branches will not touch each other. This should also prevent the roots of the one tree from intermingling with those of others, for, as a rule, the roots extend no further than the branches of well formed coffee trees. Much greater distances would not be economical, as they would result in unutilized soil. In countries like Brazil, where coffee can be planted on flat lands and plowing and other machine work between the rows is possible, much greater distances, for instance, 15x15 feet, can be used to excellent advantage; but in Porto Rico, with its very hilly formation, plowing and

cultivation between the rows will most probably remain an impossibility.

Experiments with plant distances, conducted by the Experiment Station, are not sufficiently advanced to show results, but probably distances of 7 x 7 feet or 8 x 8 feet, giving respectively 888 and 680 trees to the acre, will prove to be most desirable.

Plant-holes

Plant-holes are made at the places indicated by the sticks, in such a way that the stick is in the center. They should be made about two feet deep and as wide as is necessary to easily make this depth with an ordinary spade. When digging, the top soil should be put to the upper side of the hole and the subsoil to the lower side.

Filling of Plant-holes.

The workman should stand in the hole and with a hoe scrape the surface soil from above and beside the hole into it, gradually stamping it with his feet, until the hole is entirely filled. When properly done the filled hole, together with the subsoil formerly placed to the lower side of it, will now have the form of a small table or plateau, in the center of which the future coffee tree will stand. During future operations this table is gradually enlarged by cutting the upper part away and drawing the earth to the lower part. These tables will allow the hoeing of the soil around the young coffee trees and prevent the washing of the soil during heavy rains.

After the hole is filled and well stamped, a little of the finest earth is heaped on top and the same marking stick again put in the center, to indicate to the planter the exact place where the young tree is to be set.

Seed and Seedlings.

Seedlings may be used either from volunteer plants out of old plantations or from specially prepared plants in seed and nursery beds. The first are apparently the cheapest, as they seemingly grow without expense. This, however, is not true, as during their growth they necessarily impoverish the soil, leaving less nourishment for the old trees and consequently reducing the crop. In many plantations in Porto Rico are found thousands of so-called seedlings, often of considerable size and completely filling the spaces between the coffee trees, and cutting off all light and air from the soil. It seems irrational that planters, who try to keep their plantations free from weeds, should allow such large numbers of seedlings to remain. They exhaust the soil just as weeds do, and like them should be removed. In a well organized plantation

nothing should be allowed to grow betwen the coffee and shade trees, as everything there grows at the expense of the coffee berries.

Aside from the above, volunteer plants do not offer reasonable security that they will grow up to strong and healthy trees. They may have grown from berries from diseased trees or other undesirable seed. When, notwithstanding, volunteer plants are used, a careful selection and inspection of the root system is necessary.

The best way to produce seedlings is to select the largest and ripest berries from the very best trees, pulp them by hand, and wash them with water mixed with fine wood ashes or charcoal powder until they are freed from the slimy covering and feel rough when rubbed between the fingers. Then put them well spread out in a shady and airy place to dry. Thus prepared seed can be planted at once or kept for some months without losing its vitality.

In the meantime seed beds should be prepared. These are best made in the immediate vicinity of each field, so that the seedlings can be transported in the shortest time and with the least expense. It is well to have 25 per cent. more seedlings than are used on the fields, so as to have them handy for replanting. When all are not required for this purpose, they may be used for other fields.

For seed and nursery beds in Porto Rico the most desirable dimensions are 15 feet long by 3 feet wide. Passageways 2 feet in width should be left between the sides of the beds and 4 feet in width betweed the ends, in order to facilitate the work of planting, weeding and watering.

After the soil over the whole extension is well prepared either by plowing and harrowing or with the hoe, the beds are staked off and the soil heaped between the stakes. For keeping the loose earth in place and preventing washing by rains, the beds may be supported on the sides by such cheap material, as, for instance, split palm trees, well pressed against the sides of the bed, and held in place by stakes. To give the necessary shade and also to prevent washing by rain, a roof is built over each two beds. This roof may be covered by palm leaves or other material, which should be put on in layers and so thick and slanting that, during the first two months, no heavy raindrops can pass through. Their height should be such that an ordinary man can easily pass under them. The lower sides of the roofs should be to the west, so that the hot afternoon sun cannot strike the plants. In cases where this is not practicable, side curtains of palm leaves or other material can be made. The soil in the beds should be well cleaned from straws, sticks, etc, well hoed, pulverized and leveled; after which the bed is ready for

planting. The evening before planting the seeds, the beds should be well sprinkled with water.

The next morning the seeds should be laid on top of the beds in straight rows two inches apart, the same interval being allowed between seeds in the rows. During the planting all damaged or broken beans and peaberries should be thrown out. After the whole bed is neatly covered with the seeds each seed is pressed a little below the surface with the finger, so that it will lay firm, and then the whole bed is covered with a layer of wood ashes and once more sprinkled with water. Each bed will contain about 1,600 seeds.

After about 40 days the seeds come up, and as soon as the first round leaves are well formed they may be weaned (transplanted in the nursery beds.)

These nursery beds are constructed exactly like the seed beds. With a round stick, about two inches in diameter, holes are made in rows six inches apart each way. These holes should be sufficiently deep to allow the taproot of the young seedlings not to touch the bottom. These beds will then contain about 180 plant-holes ready to receive so many seedlings.

The young seedlings are now taken out of the seed beds with any kind of a wooden instrument, and their roots and development inspected. Those that have bent taproots or are not well developed are thrown out. Of the balance the taproots are cut with sharp scissors to a lengh of about four inches from the root collar and then planted in the holes by putting them straight against one side and while holding them immovable with one hand, pressing the earth firmly around with the other, putting this hand straight in the soil and pressing firmly towards the plant. Care should be taken that after the earth is pressed around it, the plant is not higher or deeper planted than it was in the seed bed. After planting the beds should be sprinkled and this sprinkling repeated during dry weather, so as to keep the soil from getting too dry. As soon as the soil gets hard between the plants it should be crumbled with a wooden knife. Weeds growing between the rows should be removed.

After a few weeks the gradual removing of the roofs is commenced by taking away one layer of leaves so that the light can filter through. This removal is repeated from time to time, according to the growth of the plants, until after they have developed 3 or 4 pairs of leaves, at which time the whole cover may be removed. After standing for some time in the sunlight and open air, the plants are ready for setting in the fields.

Planting.

Planting can be done on any day of the year when the

soil is moist and the sky cloudy or partly so. This will, of course, occur in the rainy months. Heavy rains, however, make the soil too wet and render it impossible for the laborer to press the soil well around the roots.

The seedlings can be used as soon as they have developed 5 or more pairs of leaves and are healthy and vigorous. All those that do not come up to this standard should be thrown out. Should the seedlings have already become so large that branches have been formed and the stems become the thickness of an ordinary lead pencil, then before planting they should be cut on stump, that is, cut off about 6 inches above the root collar.

The surest way to plant is with the clod, that is, the plants are removed by means of a small spade or even machete with the clod of earth in which the roots have grown, transported in baskets to the place of their destination and planted. This transportation is easily done by boys, who carry 5 or 6 at a time, and as the nursery beds are near the expense is so slight that the method is preferable to the planting with bare roots.

Remove one of the ends of a bed and cut through the soil deeply midway between the first rows, then cut at right angles midway between the plants in the rows. By now pushing a sharp, flat spade beneath each plant at sufficient depth not to molest the roots, clods can be easily taken out with little disturbance to the plant roots. All roots extending beyond the clods should be cut off with sharp scissors. Some clods will crumble off and then, of course, the plants have to be planted with bare roots. Never expose the roots to the sun.

For setting the plants, the filled holes are once more stamped with the feet, and the soil leveled by scraping the surplus earth to one side or adding more earth, as the case may be. Then by means of a round pointed piece of wood, of about 6 inches diameter, holes are rammed in the center of the filled-in plant-holes, deep enough for the plants to be put in with the root collar only a very little below the surface of the soil. The laborer now takes the clod in his left hand, so that his fingers support it from underneath, and lowers it into the middle of the hole, not touching the sides or bottom, and so deep that the root collar is just a shade below the surface, taking care that the plants remain in a perfecty vertical position. With the other hand he now carefully puts the surplus earth from the top underneath and beside the clod, gradually pressing it tight with the hand, until the hole is entirely filled and the plant stands firm and straight. Care should be taken that no openings remain underneath or beside the clod, for these may afterwards cause rotting.

Notwithstanding all precautions, some plants may die or

grow up to be undesirable ones; such plants should, at the first opportunity, be removed and new seedlings planted in their place.

Where seedlings in the nursery beds have grown too tall, that is, have formed many branches, they may be left in the beds until their stems have attained the thickness of an ordinary lead pencil or more, and used for planting as stumps.

These seedlings cut off at about 6 inches above the soil and called stumps, are planted in the same way as other seedlings but are more hardy and can be planted even when the sun shines, always taking care that the roots are not exposed to the sun during the transportation. A few weeks after they have been planted many shoots or suckers are developed, and as soon as some of these have attained a length of about two inches, all but one should be carefully removed with the pruning knife or small sharp scissors. The remaining shoot grows very quickly and the stem grows thicker and stronger than those of entire seedlings. The disadvantage is the extra work required of removing the first and subsequent shoots that may come up.

The question of whether to plant with entire seedlings or stumps is greatly dependent upon the fields ready for planting. As soon as a field is ready it should be planted. This will save the expense of weeding before planting, and for this reason it is economical to plant with whatever good seedlings that may be available.

When transportation of seedlings with clods is difficult, planting with bare roots may be done, but only with seedlings not yet having developed branches, or with stumps. The taproots should always be cut off with sharp scissors at the point where they bend easily, and the sideroots well trimmed. After the hole is made in the filled-in plant-hole, the plant should be put in straight against the upper side of the hole, taking care that the taproot remains straight and does not touch the bottom; the sideroots should be placed in as near their natural normal position as possible. With the left hand the plant is held immovable against the sides, the root collar being just a shade below the surface. Then with the right hand slowly fill in the hole and gradually press the earth, around and against the roots, until the plant stands firm.

Shade and Shade Trees.

To protect the coffee from the direct rays of the sun, shade trees should be planted. The density of the shade required depending upon the altitude of the plantation; the higher the altitude the less shade.

Experiments regarding the density of shade at different altitudes are not yet sufficiently advanced to give results; but

the shade trees may be planted at double the plant distances of the coffee. If after the trees are grown they should prove to stand too near each other, those in excess, can easily be removed while young, without injury to the surrounding coffee.

Two varieties of shade trees are favourably known in Porto Rico, viz., the Guamá and the Guava. The Guamá is a very strong tree, which might be used in parts where strong winds prevail, but otherwise its shade is too dense. The Guava is not so strong, but gives an ideal shade; the form of its crown is of the umbrella shape, and it can be easily pruned. The light filters easily through its foliage, at the same time not allowing the full sunlight to shine heavily on the coffee. For seedlings, volunteer plants are generally used, but no doubt a better and more rational method would be to grow them in nursery beds. The volunteer plants are carefully drawn out of the soil, cut off on stump at least 6 inches above the root collar and planted at the required distances between the coffee rows, the same method described above for the setting of coffee seedlings should apply to volunteer shade seedlings. Only healthy looking plants should be used. The stumps will very soon develop suckers, all of which except one have to be carefully removed when tall enough. This removal of shoots, for coffee as well as for shade, is more easily done by a special man, during the time of the weeding of the fields.

Care should be taken that the shade trees are always planted in the center between four coffee plants, and the best time to set them is before the coffee is planted, although it may be done at the same time or a little later.

Both coffee and shade will grow up together, but the latter in a few years will have grown much the taller and afford shade to the coffee trees at the time they may require it. In the first years coffee does not require shade, but on the contrary will grow quicker and stronger in the full light. When the shade trees have grown up they should be kept well pruned, so that they will not shut out the light and air. They should have the umbrella shape and allow the light to filter through easily.

Work in the fields.

The fields should be kept well weeded. Remove the weeds as soon as possible and always before they produce seeds, and soon the weeding will become very easy and comparatively inexpensive. When once the weeds are allowed to produce seeds their numbers will be greatly increased, and the apparent saving by weeding only once or twice a year will soon be found to be far more expensive than continuous weeding.

In the old plantations in Porto Rico, weeds have been allowed to produce seeds so many times that weeding has become very expensive. Clean fields mean large crops; weeds mean less crop or no crop at all. Let everyone remember this and from the beginning work toward suppressing the weeds.

When planting is over and the soil has become hard, cultivation is necessary. The most practical way to do this is to cultivate in a circle around the trees, gradually extending the area with the growth of the branches. This will be all that is required by the root system, which, as a rule, does not extend further than the length of the branches. The first cultivation, however, should always be done outside the original plant-hole.

Cultivate as many times as possible when the soil has become hard by heavy rains or baked by the sun. The better the soil is kept loose the better the tree will grow, and the more abundant will be the crops. In the hilly regions of Porto Rico there is, however, a limit to the cultivation, depending upon the more or less steep formation of the land. When further cultivation in wider circles becomes impossible or gives rise to the washing away of the soil, then, of course, it should be stopped. The formation and gradual increase in size of the loose tables made at the time of filling the plant-holes, will be found very useful at the cultivation.

Shoots and suckers should be continuously removed, and after the harvest dead branches and undesirable parts cut away.

Coffee trees will bend over and their lower branches die off. In such cases a lower shoot should be allowed to remain, which will quickly grow into another stem. When this stem comes into bearing, the original one, if having only a few branches, may be cut away. If the original tree is a strong and healthy one, two or even three shoots may be allowed to grow, but it is better not to allow too many, as so many shoots, will necessarily thicken the plantation to such an extent that light and air are shut out and, consequently, crops become smaller.

Cleanliness, light and air are the greatest friends of the planter.

FIG. 1.—PORTO RICO STATION—COFFEE-SEED BEDS UNDER ARTIFICIAL SHADE.

FIG. 2.—PORTO RICO STATION—COFFEE CROP, 1901. LEAVES REMOVED IN 1900 TO COMBAT LEAF MINER.

Fig. 1.--Porto-Rico Station--Foreman's House at the Coffee Experiments.

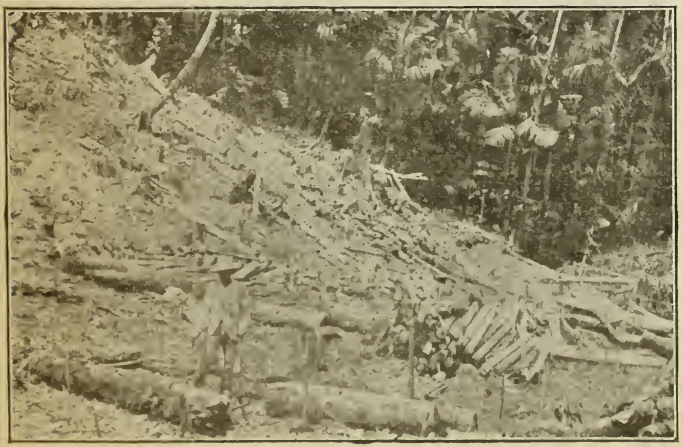

Fig. 2 -Porto Rico Station--Felling the Virgin

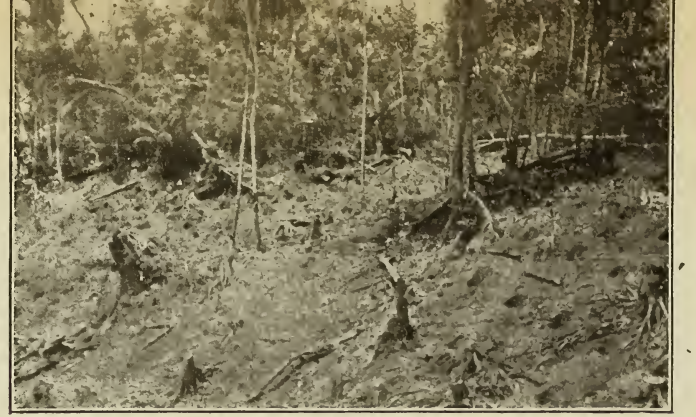

Fig. 3.--Porto Rico Station--Preparing Plant Holes for Coffee

Fig. 4--Porto Rico Station--Original Condition of Old